Reducing the impact of DG on distribution networks protection with reverse power relay

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Abstract

The assimilation of distributed sources in to existing distribution networks (DN’s) will bring up the several technical, economical and regulatory questions. Conventional distribution system is radial in nature, characterized by a single source feeding a network of downstream feeders. Therefore the voltages decrease towards the end of the feeder from the source, The incidence of distributed generators (DG) in the distribution networks alter the radial nature of distribution, causes the power flow in reverse direction in the event of DG is added in a system, or any fault in the feeding source/end, the DG exceed the local load, that is, towards the high voltage grid, it causes the existing protection system fails to protect the distribution networks against these changes.

To solve this problem reverse power relay (RPR) is proposed to protect the system voltage fluctuations, power reversals condition. The proposed Reverse power relay is a directional power relay it monitor the power flow from a generator (centralized) running in parallel with another generator (DG) or the utility. The reverse power relay prevents a reverse power in the network by disconnect the DG from the distribution network under faulted condition. It also estimates the reverse power and proposes corresponding adjustment value to provide solution to protect distribution network as per the relay settings and distribution system changing scenario. The simulations have been performed using matlab/simulink.

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1. Introduction

Photovoltaic cells power generation as a distributed generation

A) Basics of Photovoltaic cells based power generation

The virtue of semiconductor materials which is present in a photovoltaic (PV) cell is unswervingly converts into direct current electricity from solar energy. When sunlight shines on an individual PV cell, the energy that the cell absorbs from the sunlight is transferred to electrons in the atoms of the semiconductor material. This excited electrons creates the electrical current in the circuit, generates electricity. PV cells are connected in series (current generation) and in parallel (voltage generation) to one another to form PV modules which is shown in the figure (1), the capacities of PV modules are depends on their geometry. Interfaced with a set of additional application-dependent system components (i.e. includes power conditioning unit used to make ready to inject in to the grid from available dc current), form a PV system.

![Figure: 1. The structure diagram of a PV power station](image)

2) Characteristics of PV power generation

The basic apparatus of PV systems is inverter. DC output fed from PV systems is altered into AC by inverters. The efficacy in integration of PV based Distributed Generation (DG) to the grid will rely on performance of the inverter. in present scenario inverters have flexible active and reactive power control capabilities along with low voltage ride through (LVRT).PV power generation (other than concentrating PV) facilitates the multi functionalities advantage that it used direct sunlight and the diffuse component of sunlight to generate electricity also , which allows its effective exploitation in maximum regions. Compared to wind power generation, PV power generation is less exigent for grid integration because sunlight is more predictable than wind.

Distributed Generation can eliminate requirement of up gradation of transmission lines to enhance electrical power up to some extent. and strengthens the remote power plants. For conventional radial feeders, without any DG, the power flows only radial nature in one direction from the feeding grid towards the loads. Therefore the voltages decrease towards the end of the feeder. the instant at which DG is added to system, in the event the DG exceed the local load and power flows (Bidirectional) reverse direction, that is, towards the high voltage grid. Hence, the power flow can either be from the grid toward loads, or vice versa. Hence, the conventional voltage control systems and protections might be in appropriate when we have DG. Previous research results have shown that DG could have significant impacts on distribution system protection, where DG integrated in to the distribution network leads to great changes in configuration and big task for its control and protection system capacity[1],

Min Dai, Mohammad N. Marwali, Jin-Woo Jung, and Ali Keyhani [2] have presented solution to the power flow control problem of a grid-connected single DG unit. the proposed approach combines voltage regulation plus harmonic minimization under island mode and decoupled P and Q control under grid-connected mode with a nonlinear local load. However the presented techniques are not providing the protection against the faults/ sudden reduction of faults with the presence of Distributed Generation sources.
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